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CAPE for CaPE

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In an effort to improve short-term forecasting for the Kennedy Space Center region, Holle et al. (1992) investigated the effects of low level wind regimes on the distribution of cloud-to-ground lightning in central Florida. With a study period of 455 days, Holle et al. (1992) found "southwest flow contributed 66% of the total network flashes while also occurring on the most days (142)." Relationships among mesoscale thermodynamic variables and precipitation and/or lightning have been addressed in previous studies in Canada (Zawadzki, et al. 1981) and the Tennessee valley (Buechler, et al. 1990). Zawadzki et al. (1981) found "soundings, surface pressure, temperature and humidity obtained from a standard observation network were correlated with rain rates given by raingages and radar." Buechler et al. (1990) found "a fair relationship between CAPE (convective available potential energy) and daily cloud-to-ground activity" with a correlation coefficient of $r = 0.68$. The present research will investigate the relationships among rainfall, cloud-to-ground (CG) lightning, CAPE, and low level wind flow using data collected during the CaPE (Convection and Precipitation/ Electrification Experiment) field program. The CaPE field program was conducted in east central Florida from July 8, 1991 to August 18, 1991.

To investigate low-level wind flow the present research uses the same wind regime classifications defined by Holle et al.(1992). For each day of the study period the mean wind vector was calculated, as described by Watson et al. (1987), from rawinsonde measurements from .3 km to 3 km (1000 ft. - 10,000 ft.). These data were obtained from the Cape Canaveral sounding nearest to 1000(GMT). When Cape Canaveral soundings were unavailable, CLASS soundings from Ti-Co Airport were used. Seven classes were defined as follows; Calm (wind speed $<= 2.0$ m/s); NE(23° - 113°); SE(113° - 158°); SO(158° - 203°); SW(203° - 293°); NW(293° - 338°); NO(338° - 023°). The phrase 'disturbed sea breeze' will be used to refer to days classified as SW and 'undisturbed' will be used to refer to days classified in the remaining six categories.
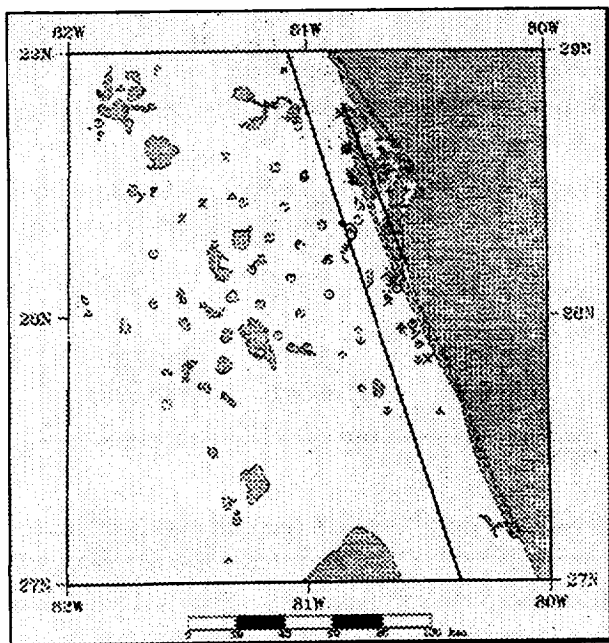

Figure 1

Daily area mean rainfall and rainrate maxima over one hour intervals were obtained from 83 raingages operated during the CaPE field program. The locations of the raingages sites are shown in Fig. 1. In an attempt to assess whether large-scale or local forcing dominates in determining the distribution and amount of precipitation, three subdivisions of the CaPE domain were defined and the number of raingages in each cluster were as follows: Merritt Island cluster - 20 gages; Coastal cluster - 25 gages; and Inland cluster - 38 gages.

Daily lightning frequency was obtained from archive data from the National Lightning Detection Network. Daily lighting frequency was calculated for the entire domain and for each of the three clusters described above. The interval 12Z-12Z was used to define a day for daily lightning frequency and daily area mean rainfall.

The sounding data used to define the day according to wind regime were also used to calculate CAPE and Bulk Richardson Number ($R_i b$). CAPE is a measurement of instability and is also referred to as available buoyant energy. The Richardson number represents the ratio of buoyant energy input into turbulence to the energy input from the shear of the mean wind flow (Fleagle and Businger, 1980). Calculations of CAPE and $R_i b$ were made using SUDS (System for User-editing and Display of Soundings) software from the Atmospheric Technology Division of the National Center for Atmospheric Research.

In an attempt to determine if CAPE will be a better nowcasting tool than low level wind flow, this study examined the dependence of CAPE on wind direction in the lower troposhere. Fig. 2 is a plot showing this relationship for each Cape Canaveral sounding. A similar plot was created for each sounding at five locations from the CaPE data sets. For each location soundings were plotted according to time of day intervals defined as follows: Morning [0400-1300) GMT; Midday [1300-2100)GMT; and Evening [2100-0400) GMT. In all cases, there does not appear to be a correlation between CAPE and low-level wind flow.
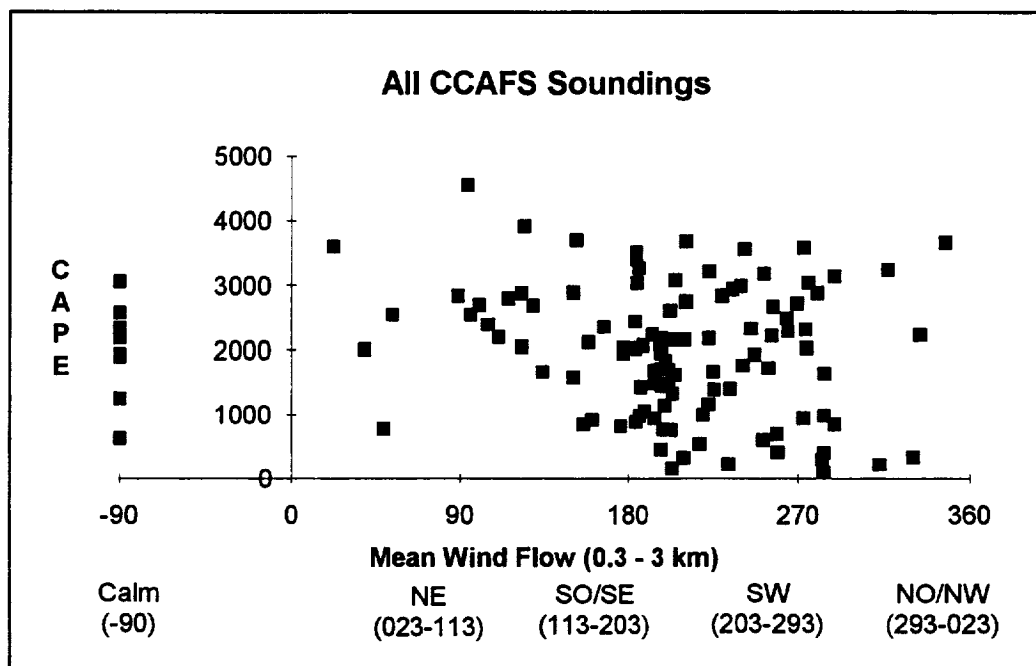

Figure 2

The next analysis attempts to answer the question "What is the correlation among rainfall, lightning, CAPE and $R_i b$ for this study period?" Cape and $R_i b$ were calculated for each day based on the sounding nearest to 1000 GMT from Cape Canaveral or Ti-Co. As shown in Table 1, poor correlations were found between CAPE and both rainfall and

lightning. Similar poor correlations were found when comparing R_ib to both rainfall and lightning.

	CAPE vs. Max. RF	CAPE vs. Mean RF	CAPE vs. Lightning	Mean RF vs. Lightning
Entire Area	-0.22	-0.39	0.05	0.44
Merritt Island	-0.33	-0.34	-0.01	0.44
Coastal Cluster	-0.27	-0.31	0.03	0.62
Inland Cluster	-0.15	-0.36	0.05	0.50

Table 1

The final analysis investigates the relationship among rainfall, lightning and low-level wind flow. Table 2 shows the distribution of CG lightning and rainfall based on low-level wind flow for the entire study area and each of the three cluster areas.

Area	Wind Flow	# of Days	% of Days	Tot. Lgt. Flashes	% of Tot Flashes	Tot. Mean RF(mm)	% of Tot RF
Entire	Disturbed	18	43.90	46132	61.67	124.87	55.52
	Undisturbed	23	56.10	28677	38.33	100.03	44.48
Merritt	Disturbed	18	43.90	679	87.39	107.80	53.33
	Undisturbed	23	56.10	98	12.61	94.34	46.67
Coastal	Disturbed	18	43.90	3833	69.20	141.54	64.86
	Undisturbed	23	56.10	1706	30.80	76.68	35.14
Inland	Disturbed	18	43.90	41620	60.77	122.83	50.38
	Undisturbed	23	56.10	26873	39.23	120.97	49.62

Table 2

For the entire study area 62% of lightning and 55% of rainfall occurred on SW-flow days which made up 43.9% of the study period. For the Merritt Island cluster 87% of the total lightning frequency occured on SW-flow days. These results support the earlier of findings of Holle et al. (1992).

In conclusion, for this study area it appears that the sea breeze propagates instability therefore larger values of CAPE are common. The low-level wind flow seems to be the better tool for nowcasting. Further study of daily rainfall and daily convection zones may increase the understanding of the role of the sea breeze in this study area.

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